Fifth Annual Conference on Carbon Capture and Sequestration May 10, 2006 - Alexandria, VA

Terrestrial Carbon Sequestration Options for the Southeast Region: Co-Firing Biomass in Coal-Fired Power Plants

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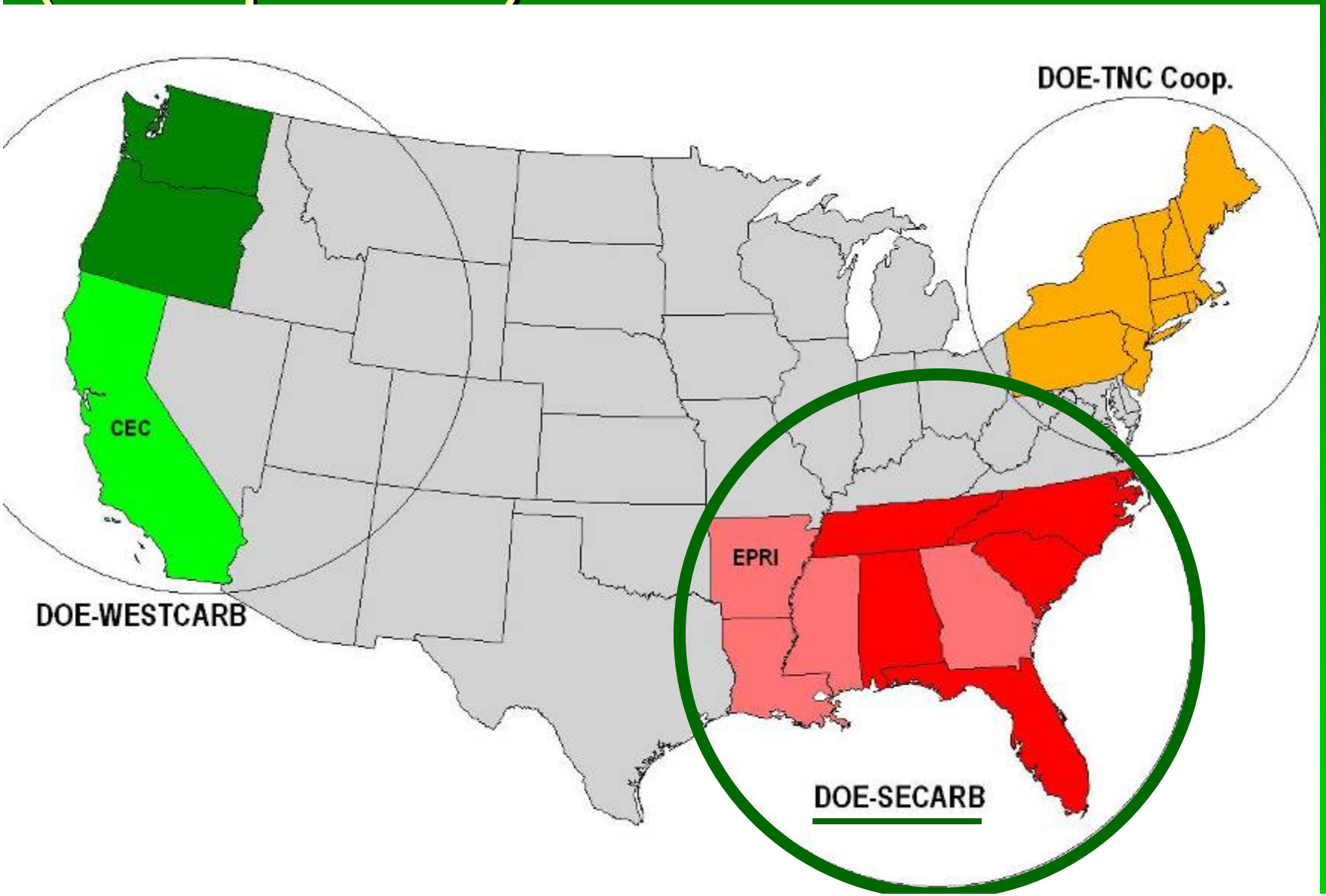
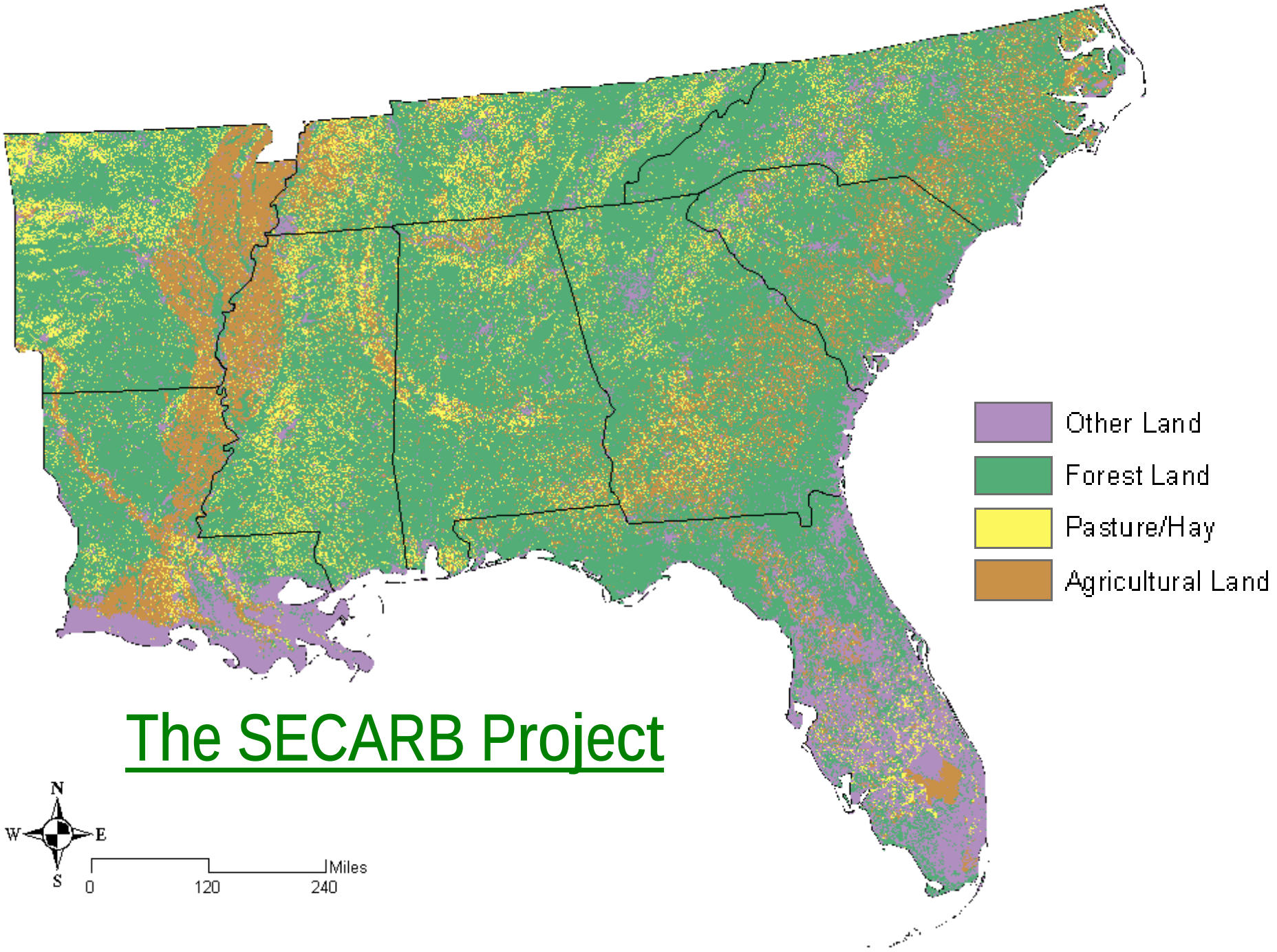
Carbon supply analysis

Regional carbon supply analyses (2002-present)





The SECARB Project

Current Land Use Dictates Sequestration Potential

In afforestation sequestration projects, the most desirable situation is where *low-value* land is readily available and has a *high capacity* for additional carbon storage (i.e. non-forest land)

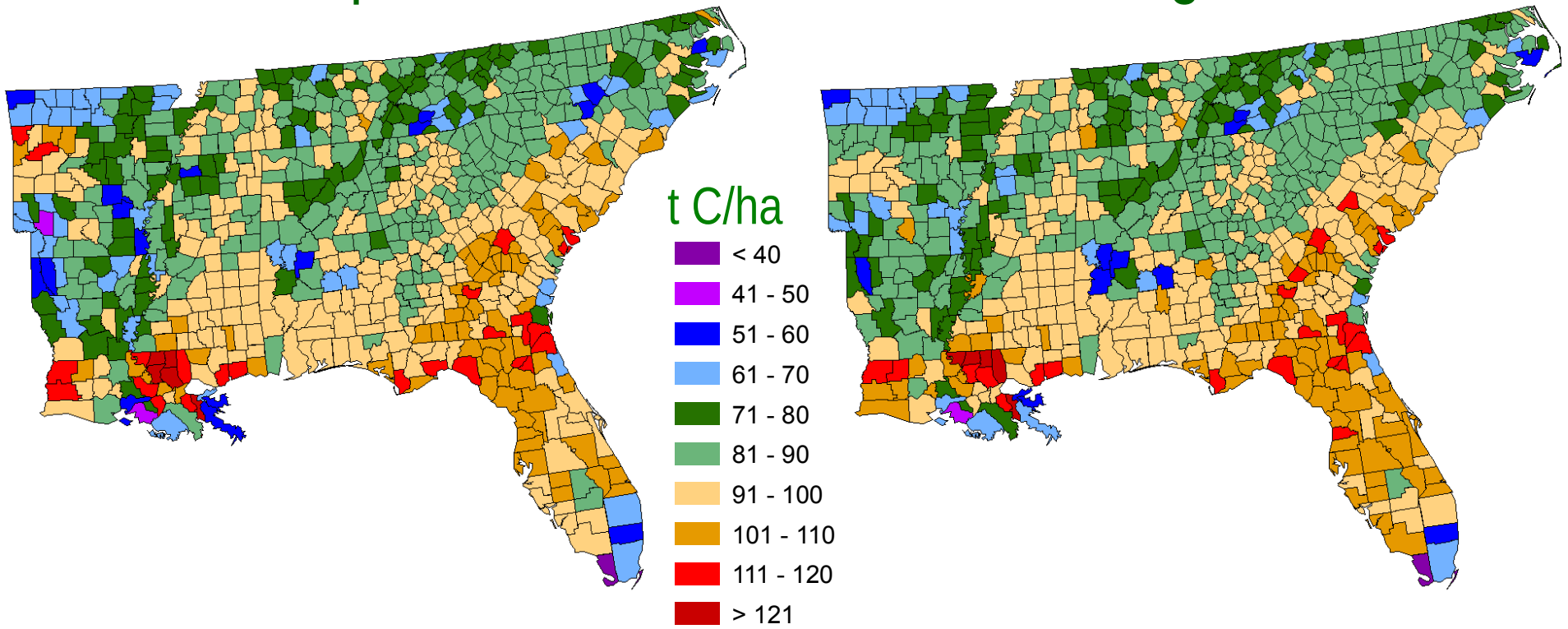
Carbon sequestration rates are factors of…

- Soil type
- Climate
- Predicted dominant tree species

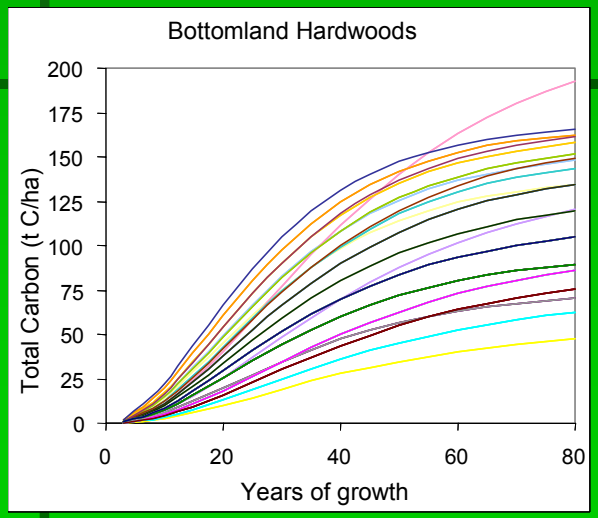
Croplands

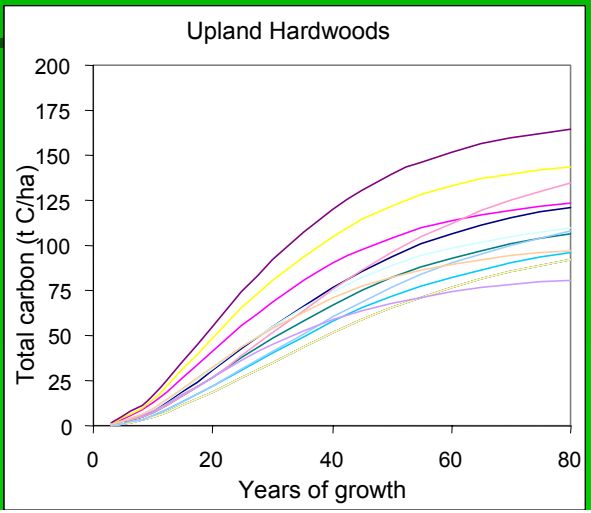
40-year projects

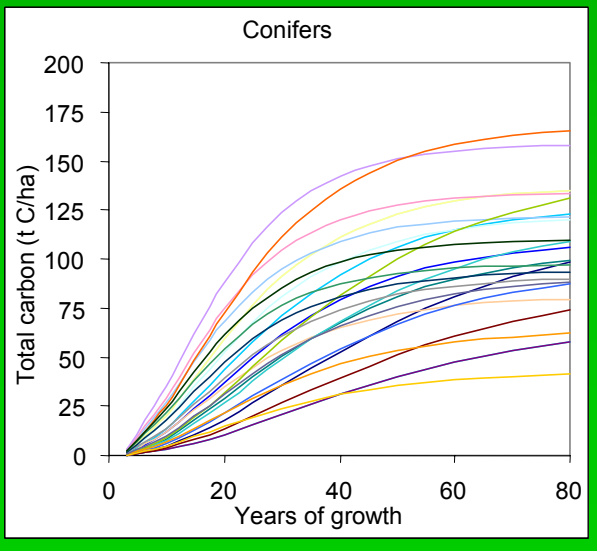
Grazing lands



Growth Rates







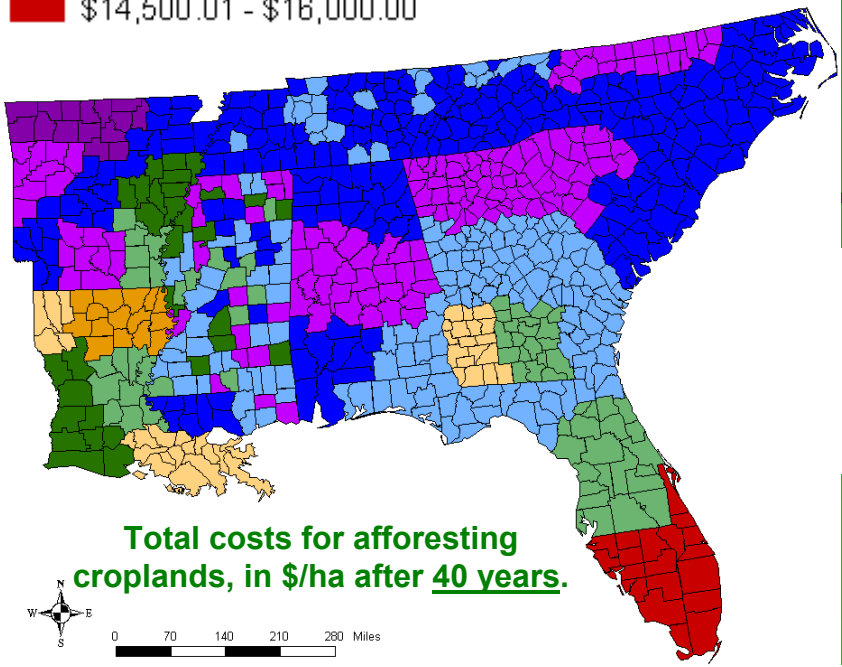
Sequestration Costs in Afforestation Projects

A function of:

- **land use conversion costs,**
- **opportunity costs associated with current land use,**
- **maintenance and monitoring costs**

Crop lands $/ha

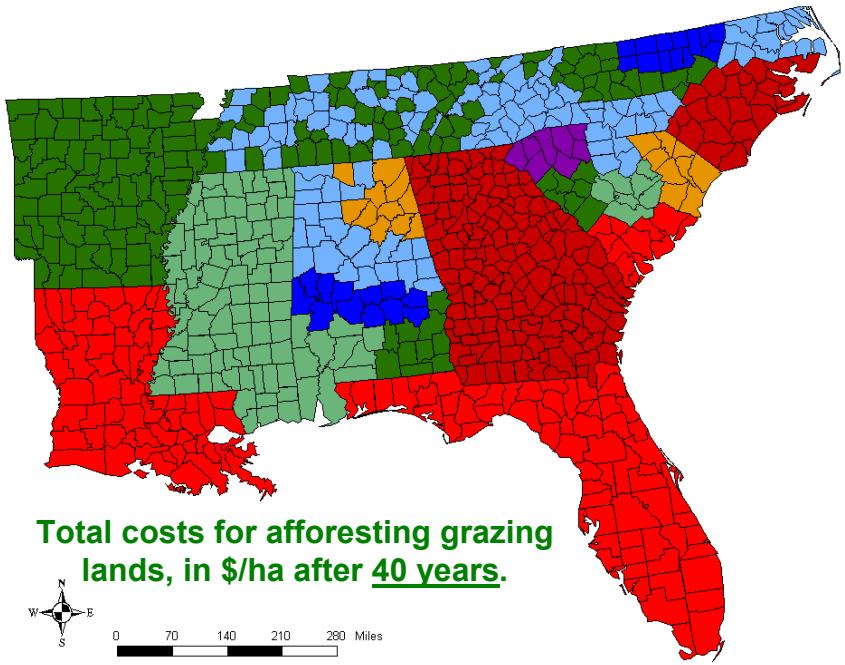
- < $1,500.00
- $1,500.01 - $3,000.00
- $3,000.01 - $4,500.00
- $4,500.01 - $6,000.00
- $6,000.01 - $7,500.00
- $7,500.01 - $9,000.00
- $9,000.01 - $11,500.00
- $11,500.01 - $13,000.00
- $13,000.01 - $14,500.00
- $14,500.01 - $16,000.00



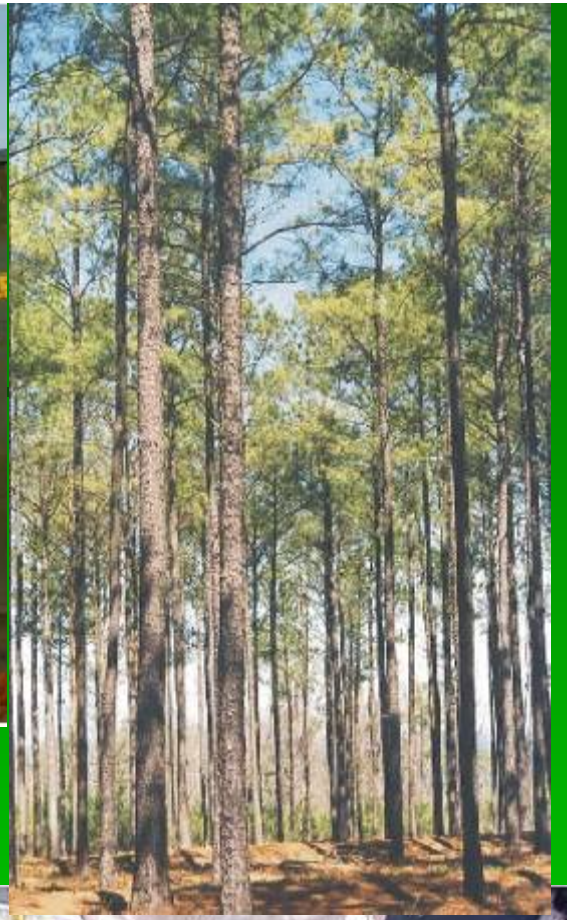
Total costs for afforesting croplands, in $/ha after 40 years.

Grazing lands $/ha

- < $1,900.00
- $1,900.01 - $2,000.00
- $2,000.01 - $2,100.00
- $2,100.01 - $2,200.00
- $2,200.01 - $2,300.00
- $2,300.01 - $2,400.00
- $2,400.01 - $2,500.00
- $2,500.01 - $2,600.00



Total costs for afforesting grazing lands, in $/ha after 40 years.



Biomass co-firing

Winrock International

What is biomass co-firing?

- A family of technologies suitable for a variety of boiler and fuel types.
- Technological feasibility has been proven with **~ 50 pilot projects**
- Winrock's focus → co-firing with forest-derived woody biomass to replace a % of coal in Southeastern US power plants.

Co-firing revenues for power producers

Revenues	Compared to coal alone
Reduction of CO_2 emissions	up to 100% CO_2 reduction*
Reduction of SO_2 emissions	95 – 99 % reduction
Reduction of NO_x emissions	up to 80 % reduction (if primary fuel is woody biomass)
Reduction of mercury emissions	~99% reduction
Promotion of renewable energy	Can be counted towards renewable energy portfolio requirements or REC's.

* More if trees or other crops will be planted for fuel.

Potential Sources of Biomass Fuel

- Forest industry residues (mill waste)
- Timber harvest slash
- Energy crop cultivation (incl. trees)

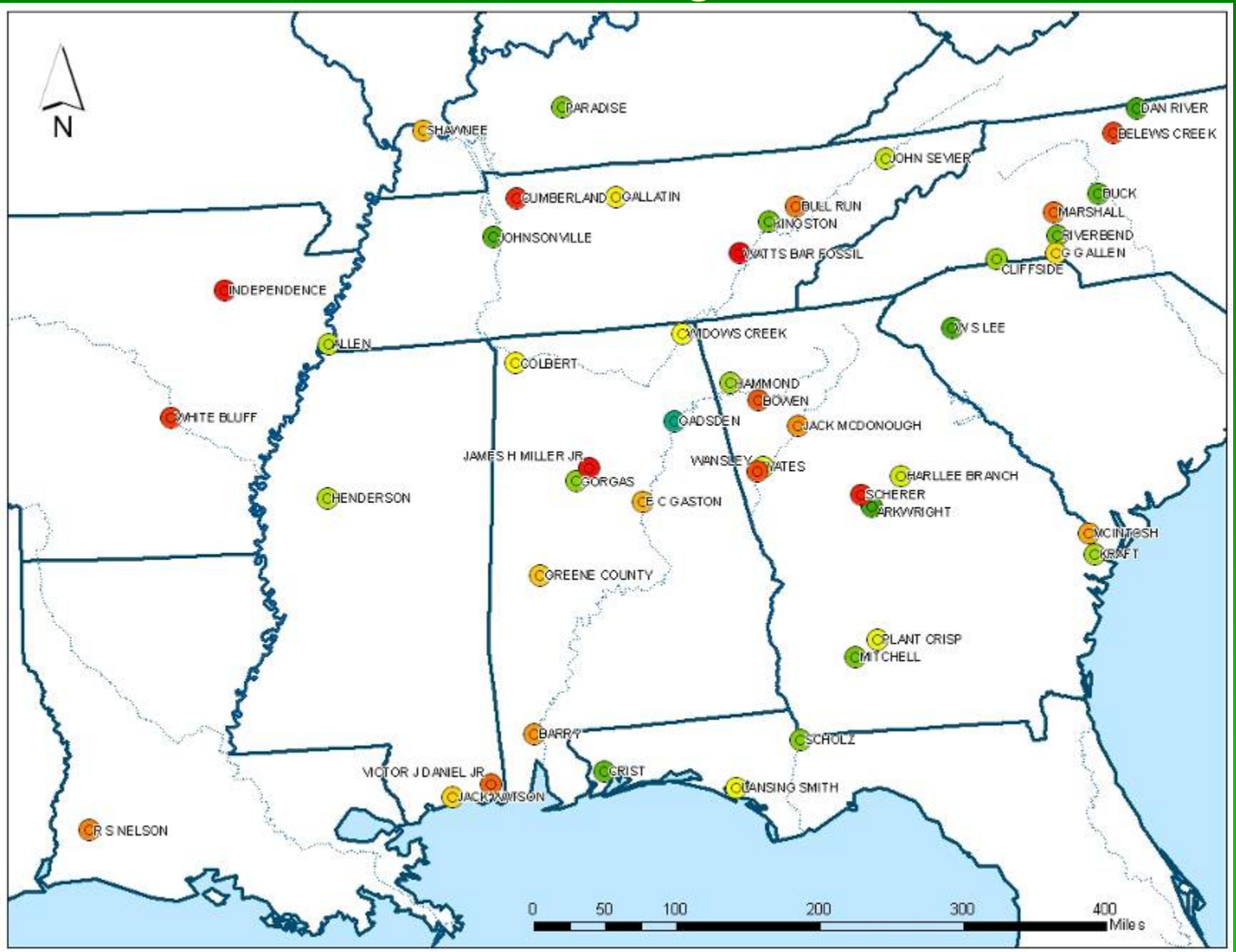
Coal plant rankings analysis

- Using the EPA's 2000 eGrid dataset, 47 coal-fired power plants in the SE-USA were analyzed for their suitability for co-firing retrofitting with short-payback periods.

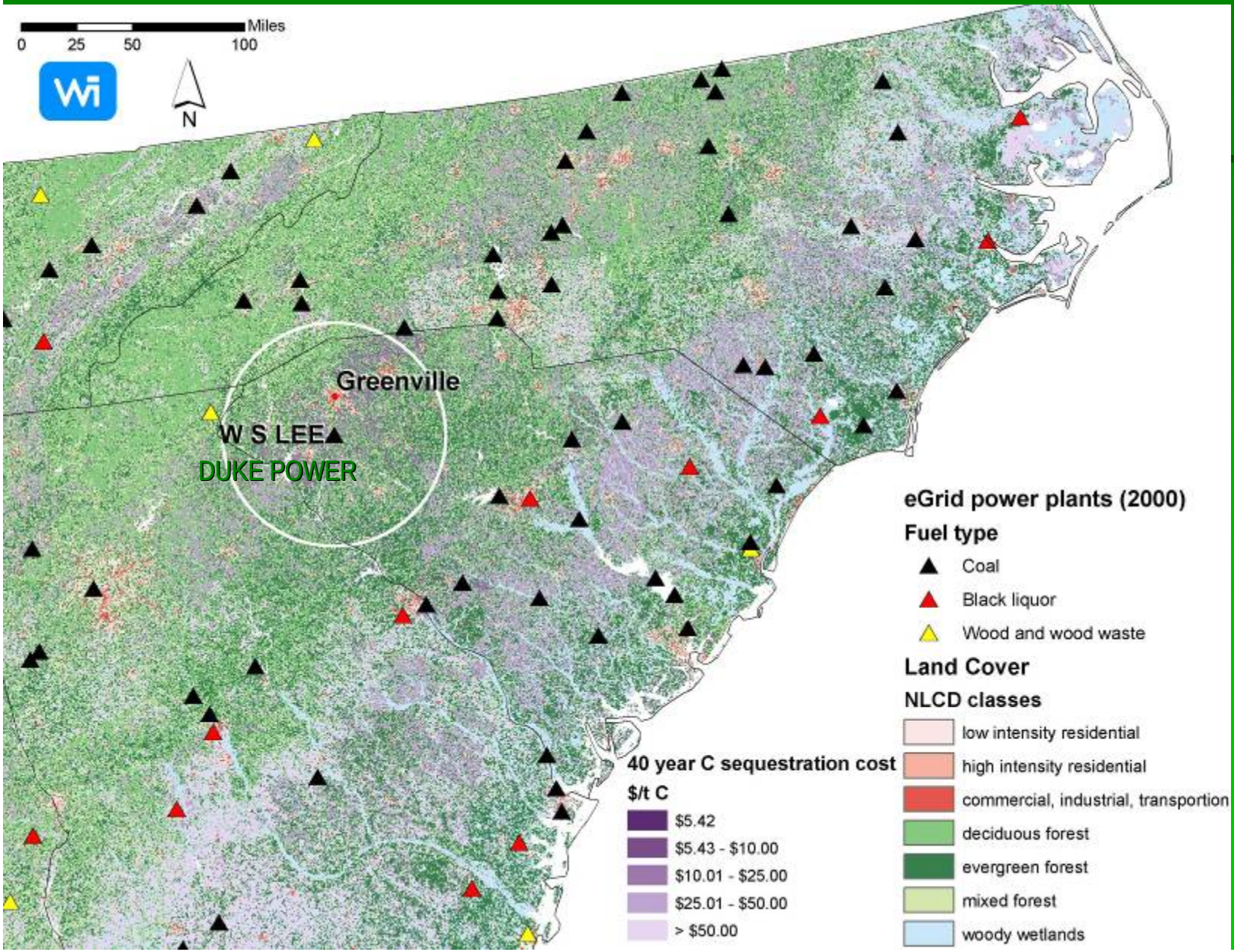
- Various regulatory and fuel-availability scenarios were analyzed.

Infrastructure Risk Rankings

Best – Med – Lower

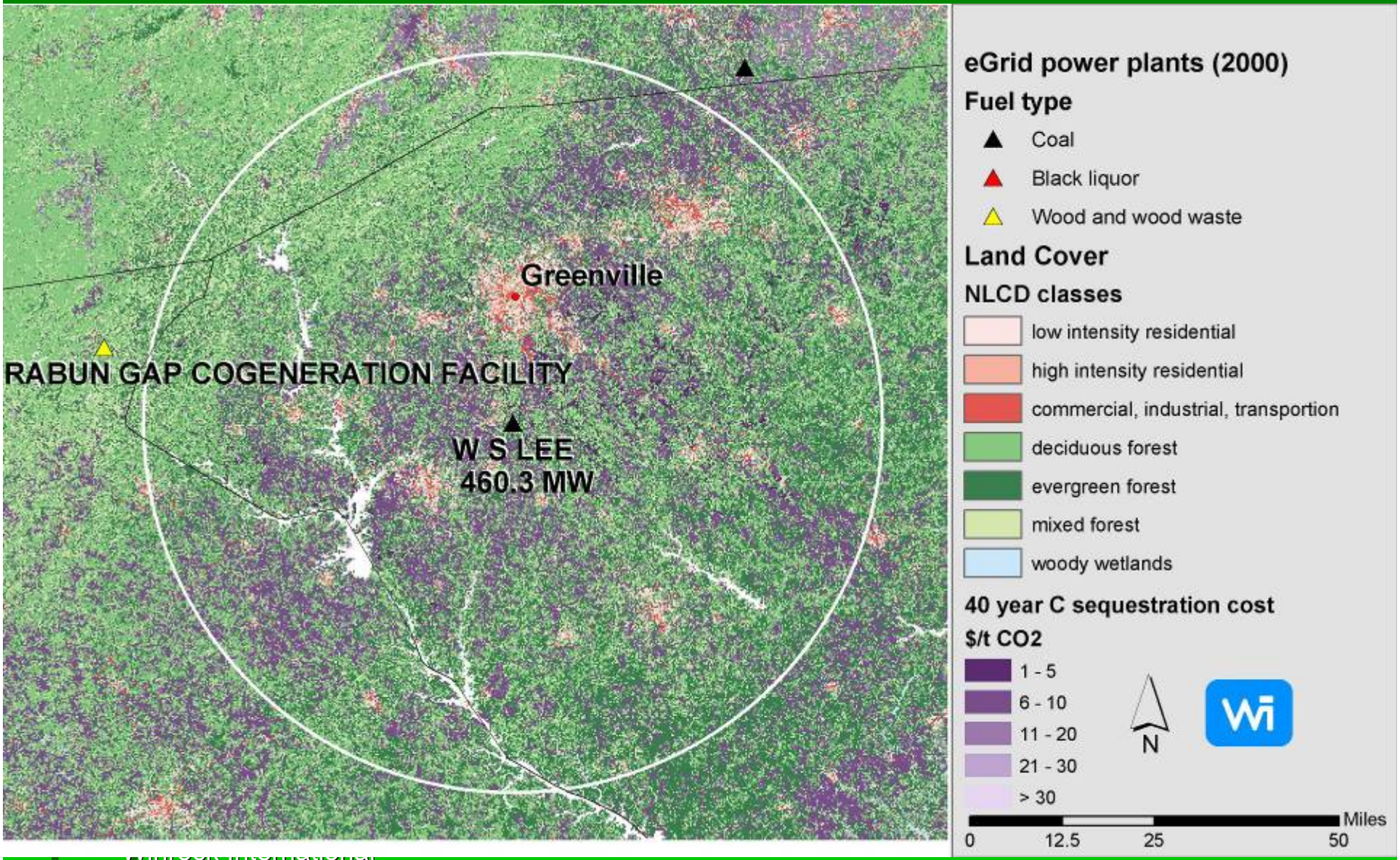


High-ranking SC coal plant under 1 scenario



50-mile fuel sourcing radius shown

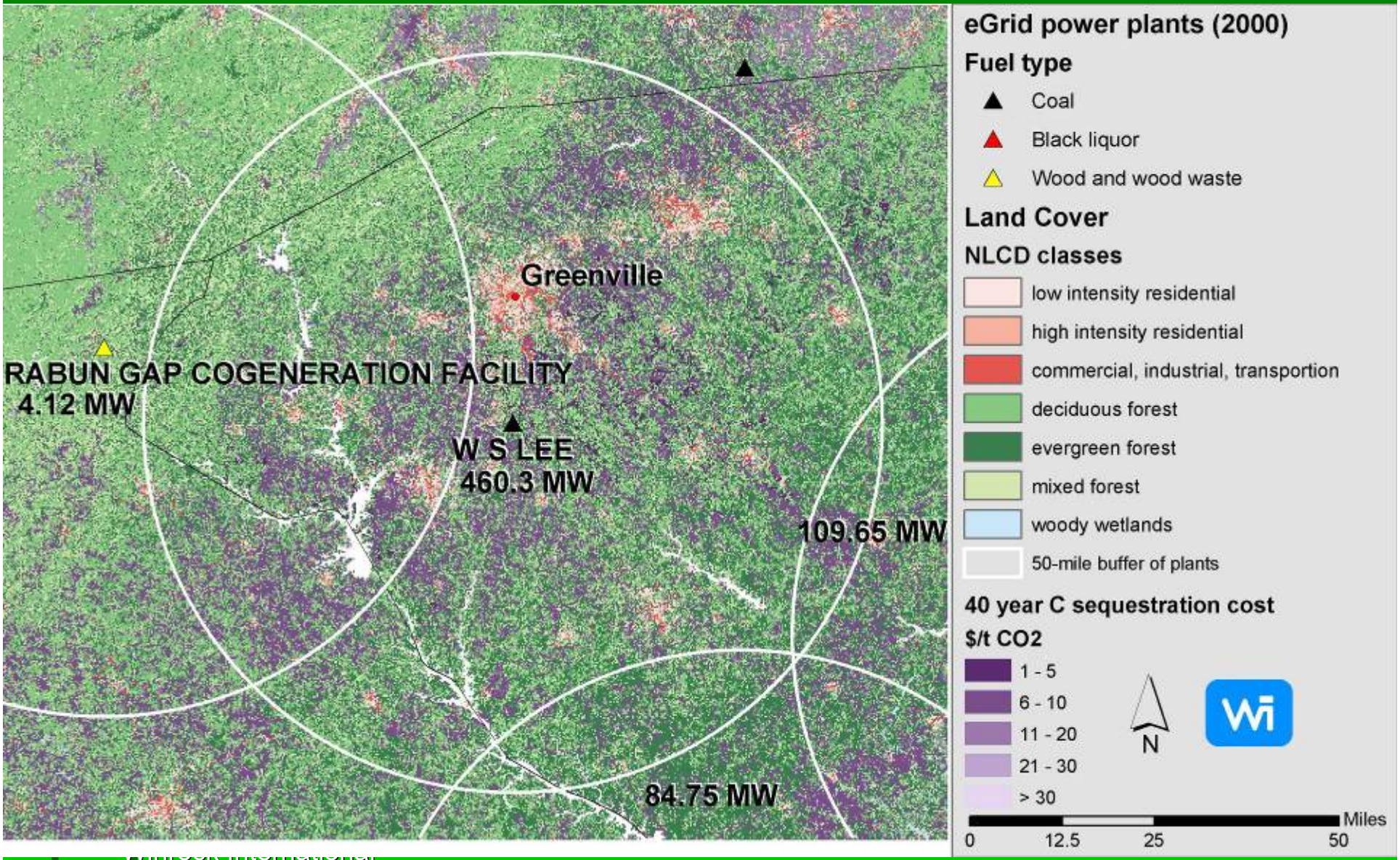
Afforestation cost: Dollars per Hectare -- 40 Years



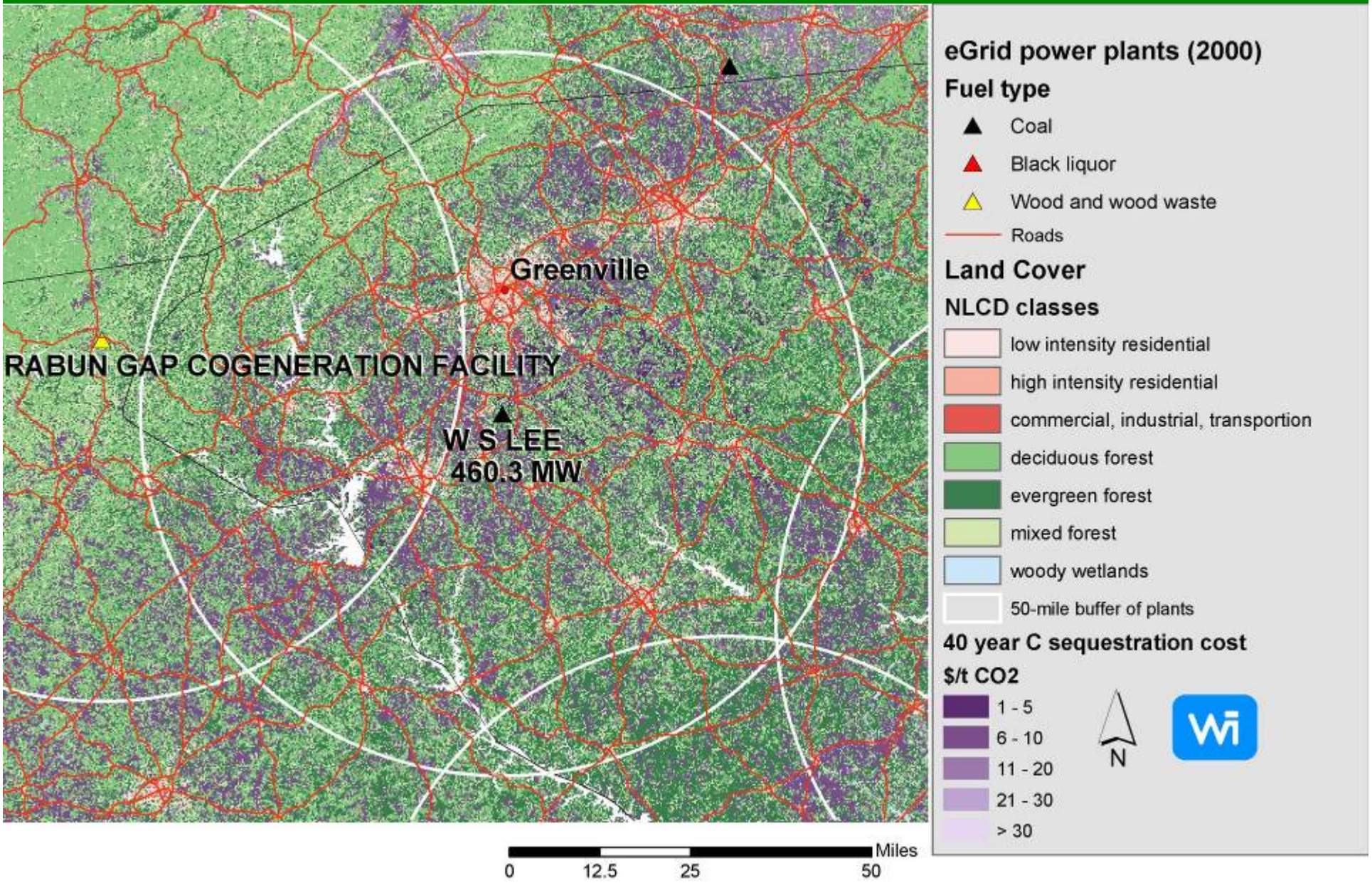
Fuel Acquisition Costs

- Moving forest thinnings & timber slash from forest to road
- Transportation, receiving & storage
- Competition for biomass

Three Competing Demands Within 50 Miles



Roads


Greenville
RABUN GAP COGENERATION FACILITY
W S LEE
460.3 MW
eGrid power plants (2000)
Fuel type
Coal
Black liquor
Wood and wood waste
Roads
Land Cover
NLCD classes
low intensity residential
high intensity residential
commercial, industrial, transportion
deciduous forest
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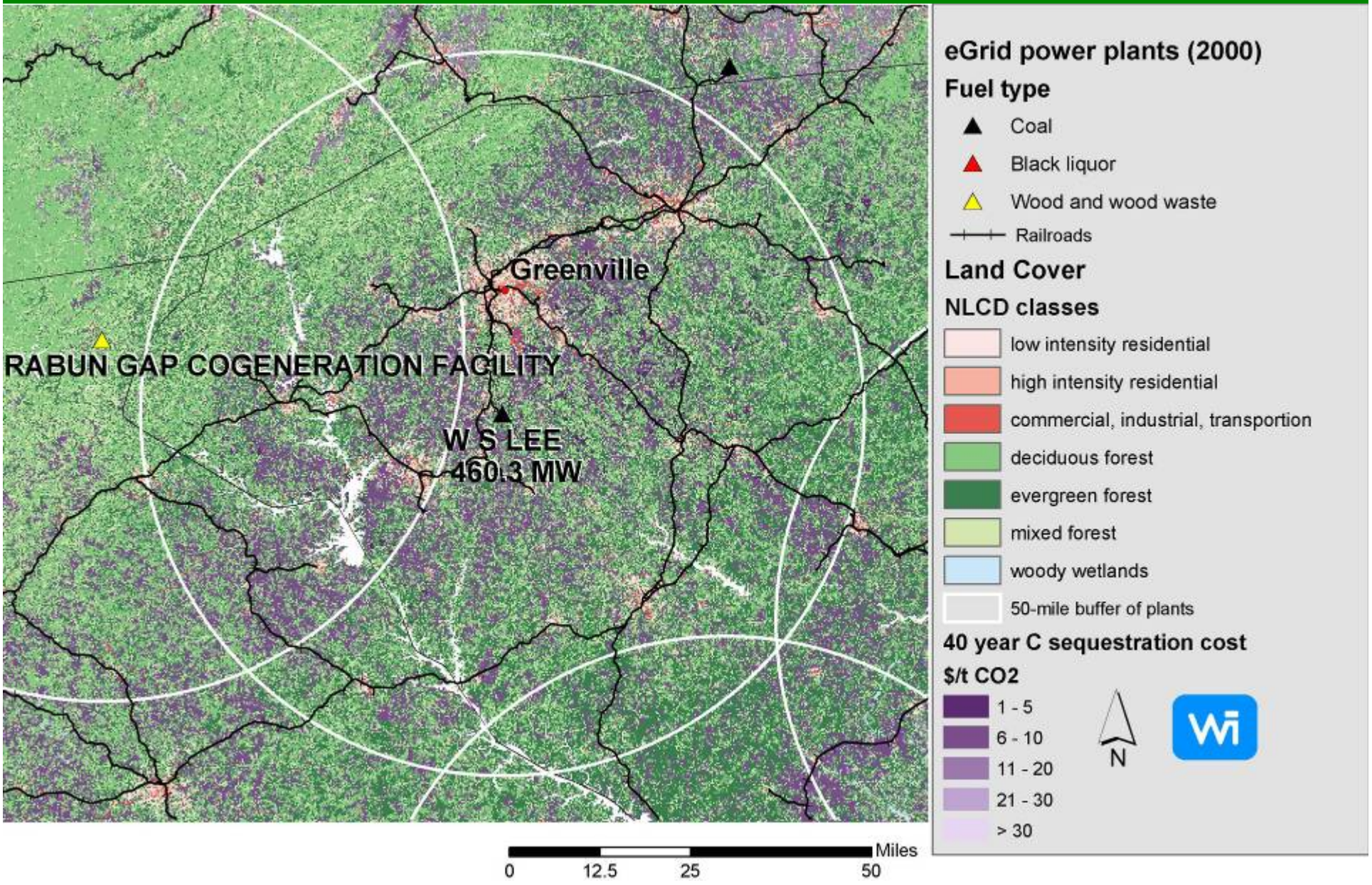
woody wetlands
50-mile buffer of plants
40 year C sequestration cost
$/t CO2
1 - 5
6 - 10
11 - 20
21 - 30
> 30
N
Miles
0
12.5
25
50

Railroads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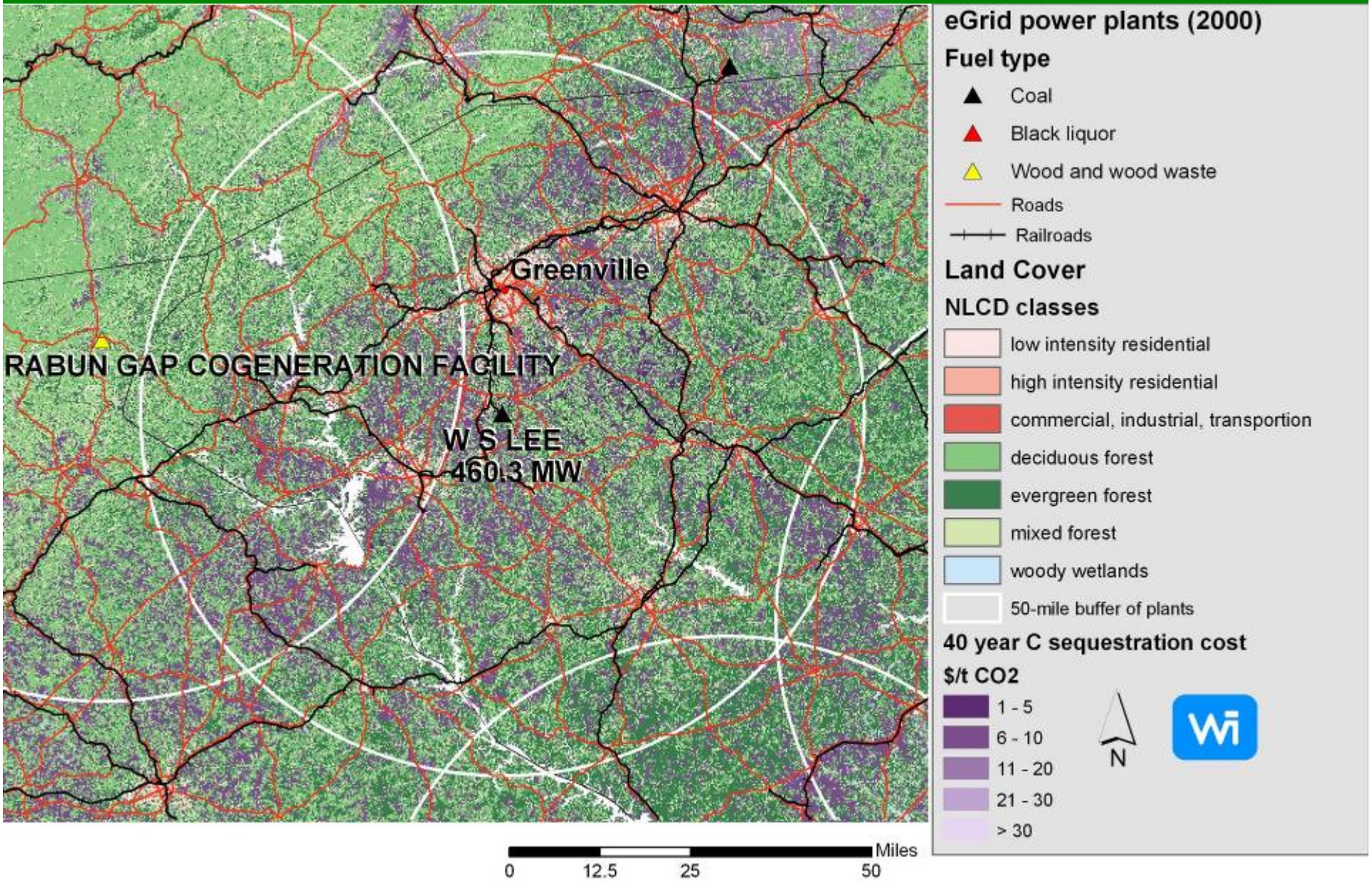
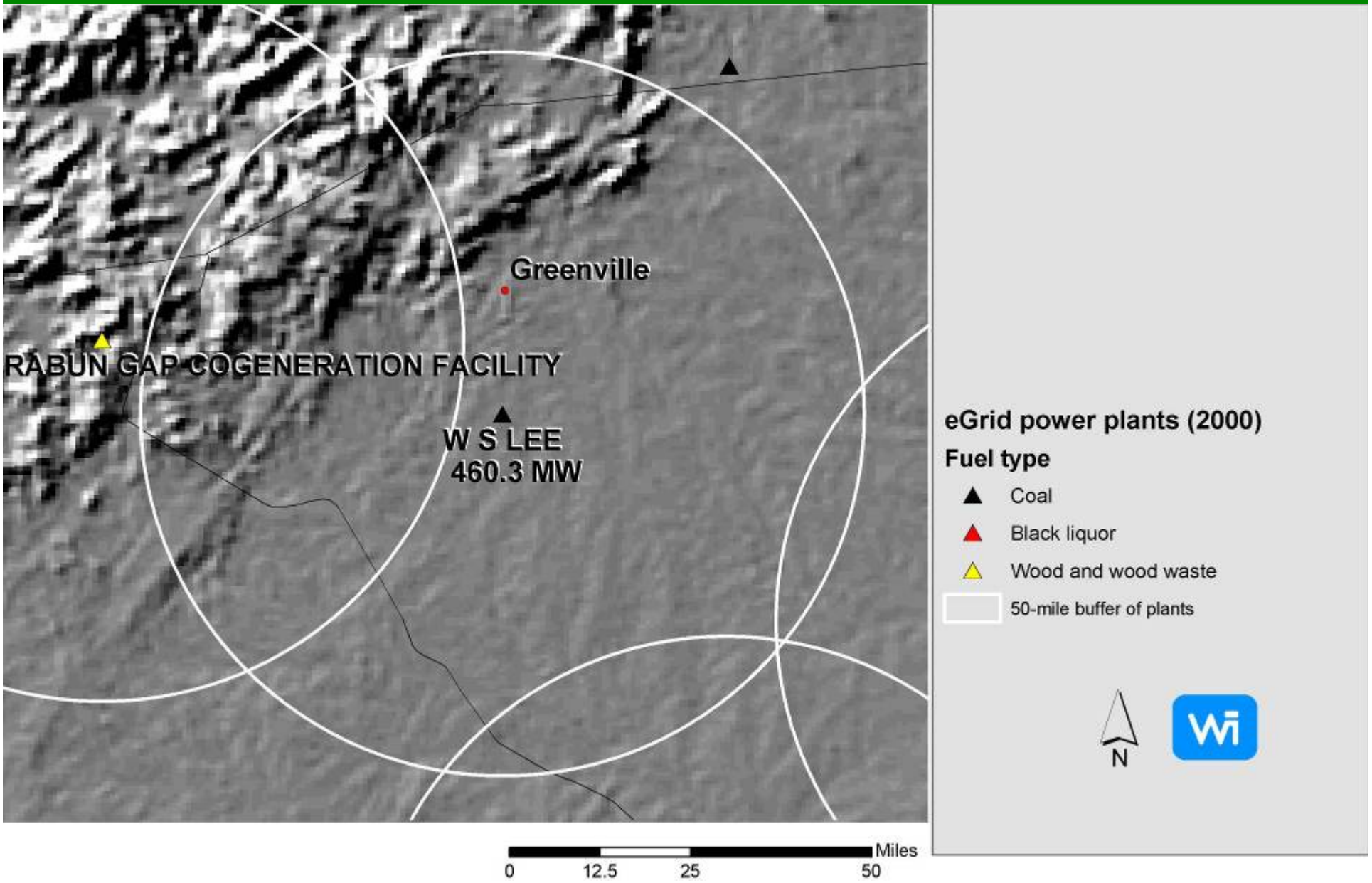
Roads & Railroads



Topographic features



Potential Terrestrial Sequestration

-- Assuming conversion to forest with 20 or 40 year rotations

Power Output	Biomass Fuel Required	Land Required	Carbon Sequestration
30 MW	212,000 MT	42,000 acres	20 yrs – 2.1 M tons 40 yrs – 6.3 M tons
50 MW	353,000 MT	70,600 acres	20 yrs – 3.5 M tons 40 yrs – 10.5 M tons
80 MW	565,000 MT	113,000 acres	20 yrs – 5.7 M tons 40 yrs – 17.0 M tons

(50-mile radius circle = 5 M acres)

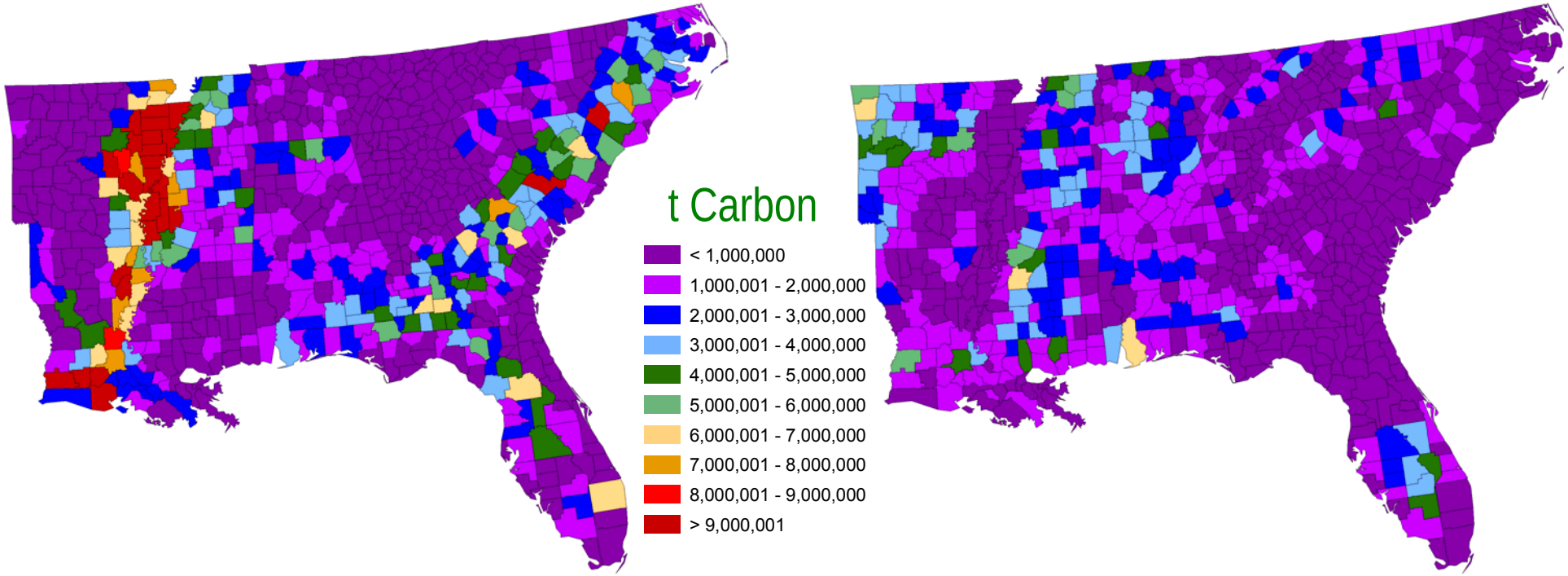
The quantity of carbon (million tons CO_2) and area (million acres) available at selected price points on existing agricultural lands after 20, 40, and 80 years of afforestation.

Activity	Quantity of C—million metric tons CO_2			Area afforested—million acres		
	20 years	40 years	80 years	20 years	40 years	80 years
Crop lands—Afforestation						
≤$10/metric tons CO_2	**203**	**308**	**388**	**2.3**	**7.7**	**7.9**
≤$15/metric tons CO_2	**1,612**	**3,880**	**4,786**	**19.3**	**28**	**28.6**
Grazing lands—Afforestation						
≤$10/metric tons CO_2	**1,379**	**3,277**	**4,310**	**16**	**24.4**	**26.9**
≤$15/metric tons CO_2	**1,735**	**3,469**	**4,353**	**22**	**27**	**27.3**

Potential C supply (t Carbon) for afforestation after 40 yr

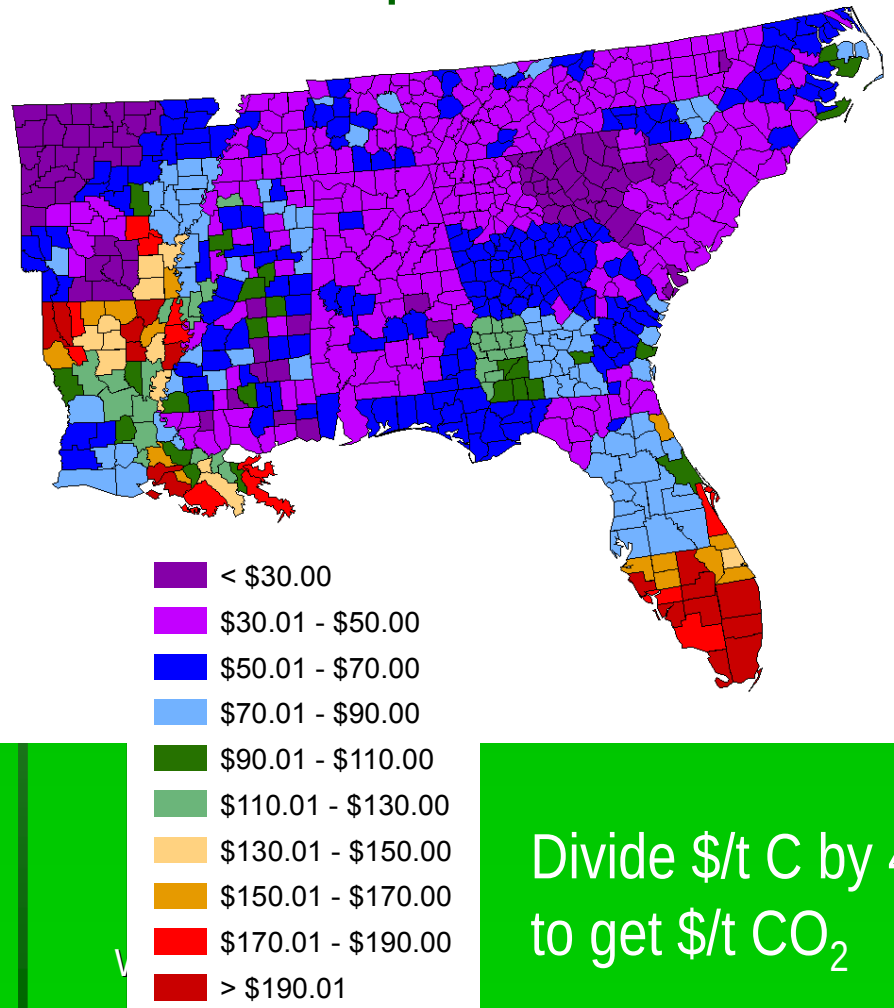
Croplands

Grazing lands



Potential C supply ($/t C) for afforestation after 40 yr

Croplands



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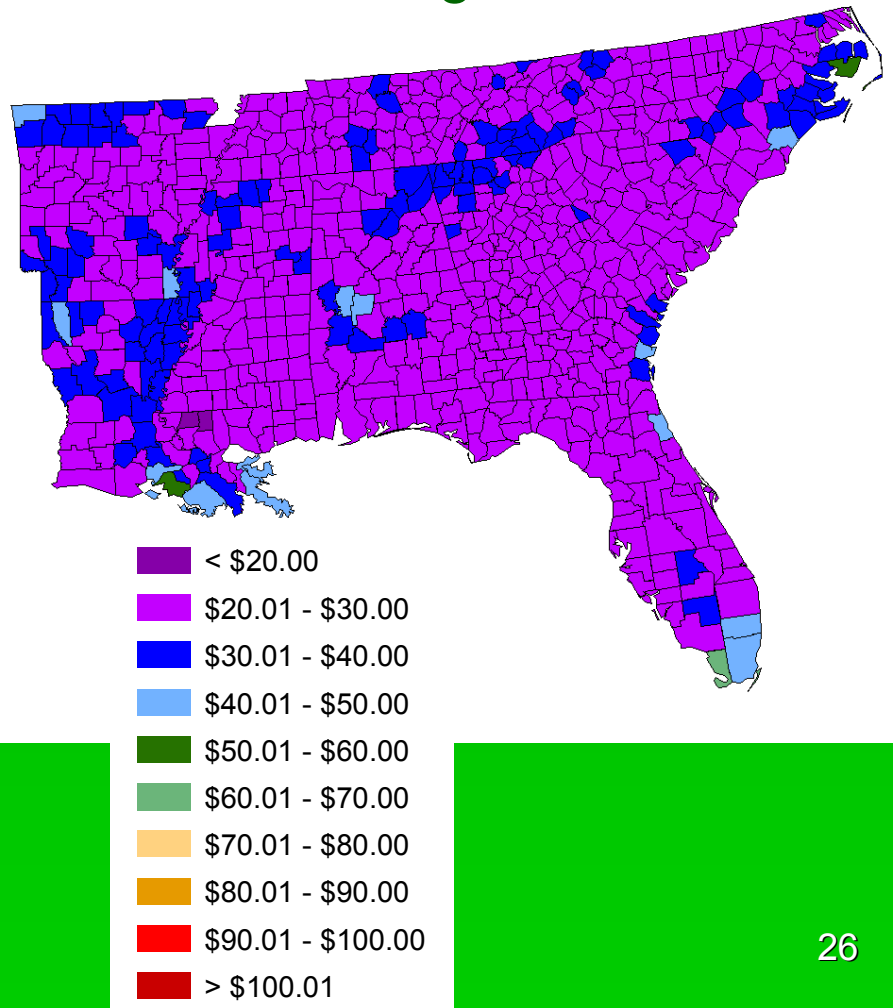
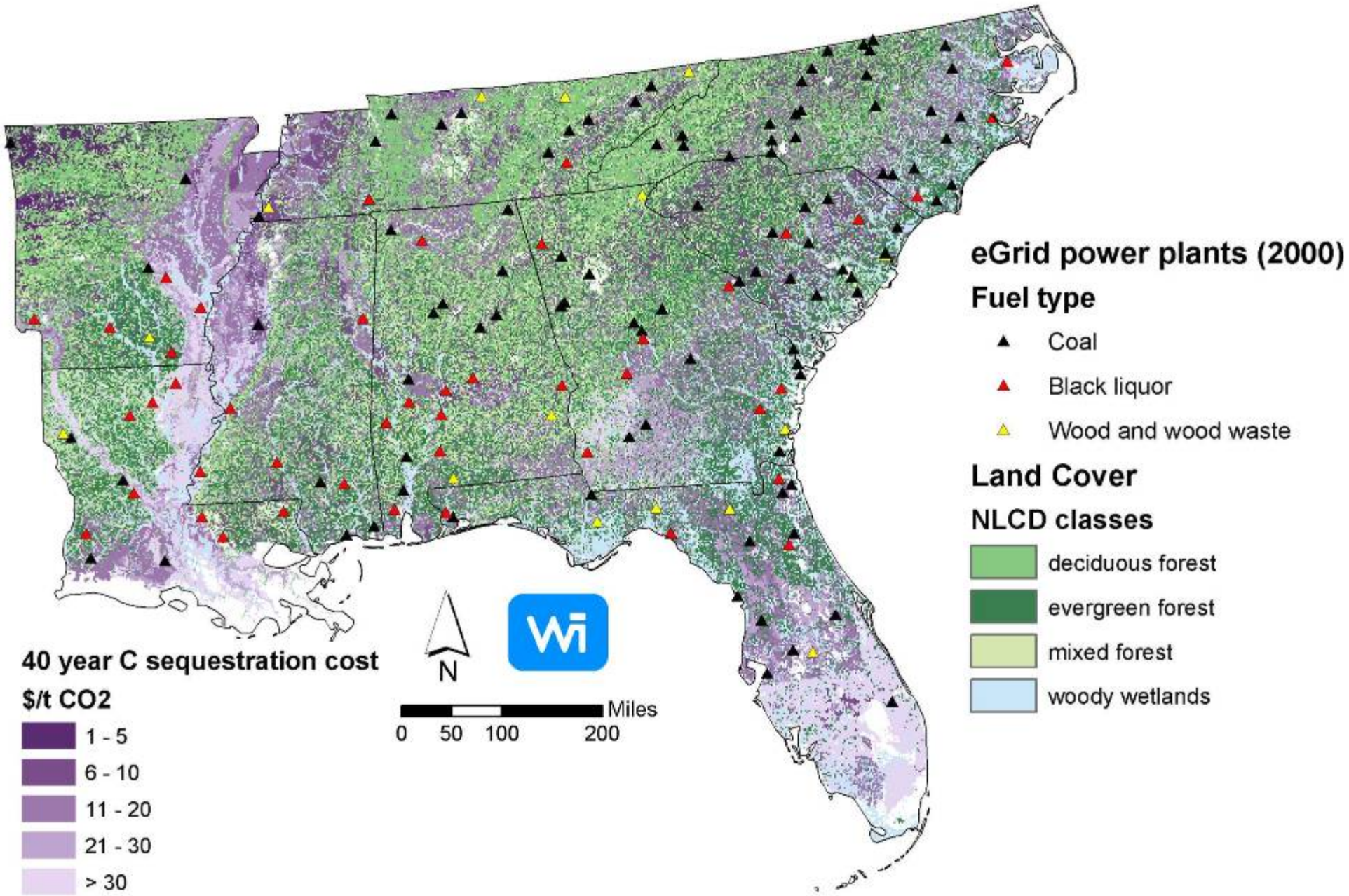


Divide $/t C by 4 to get $/t CO_2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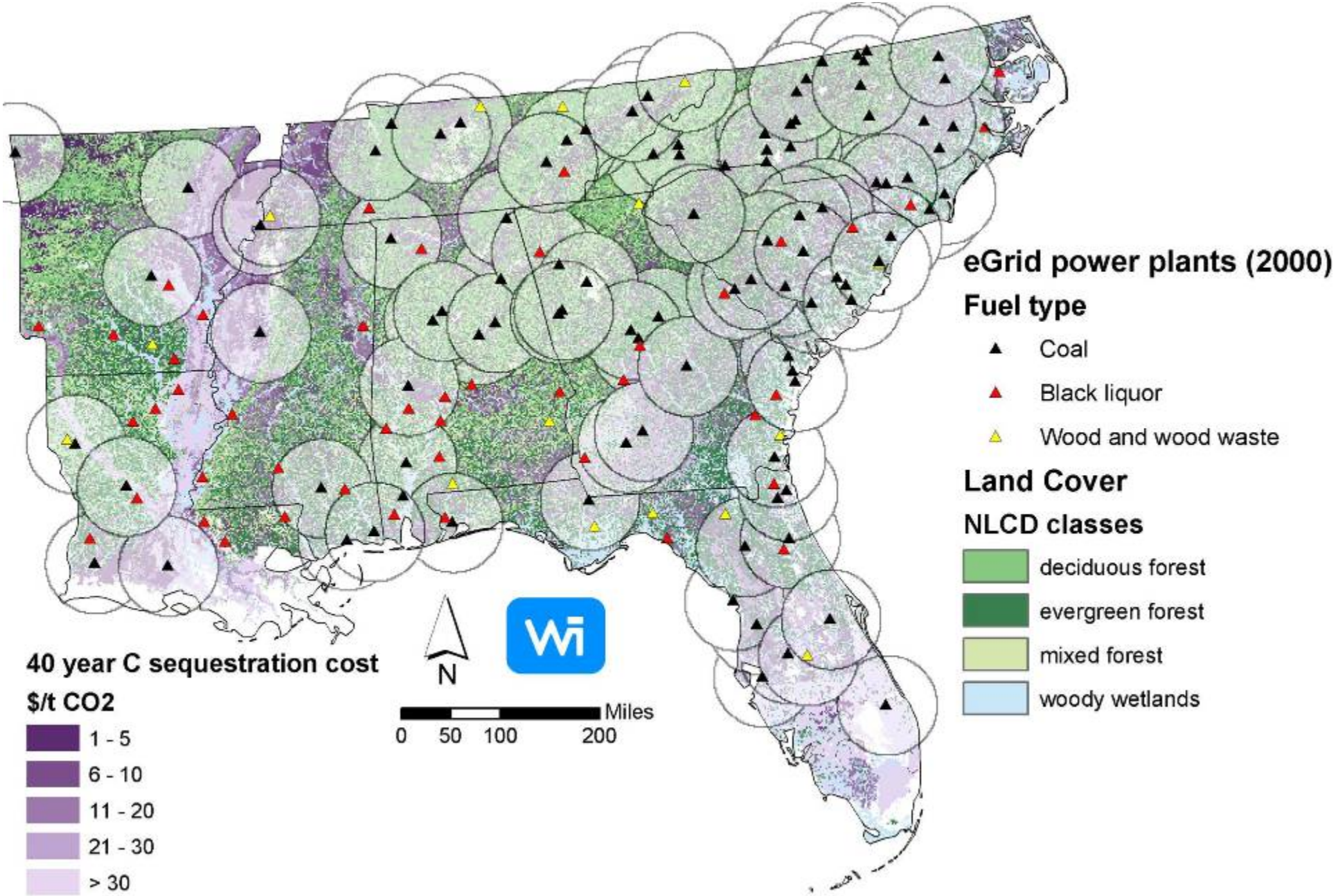
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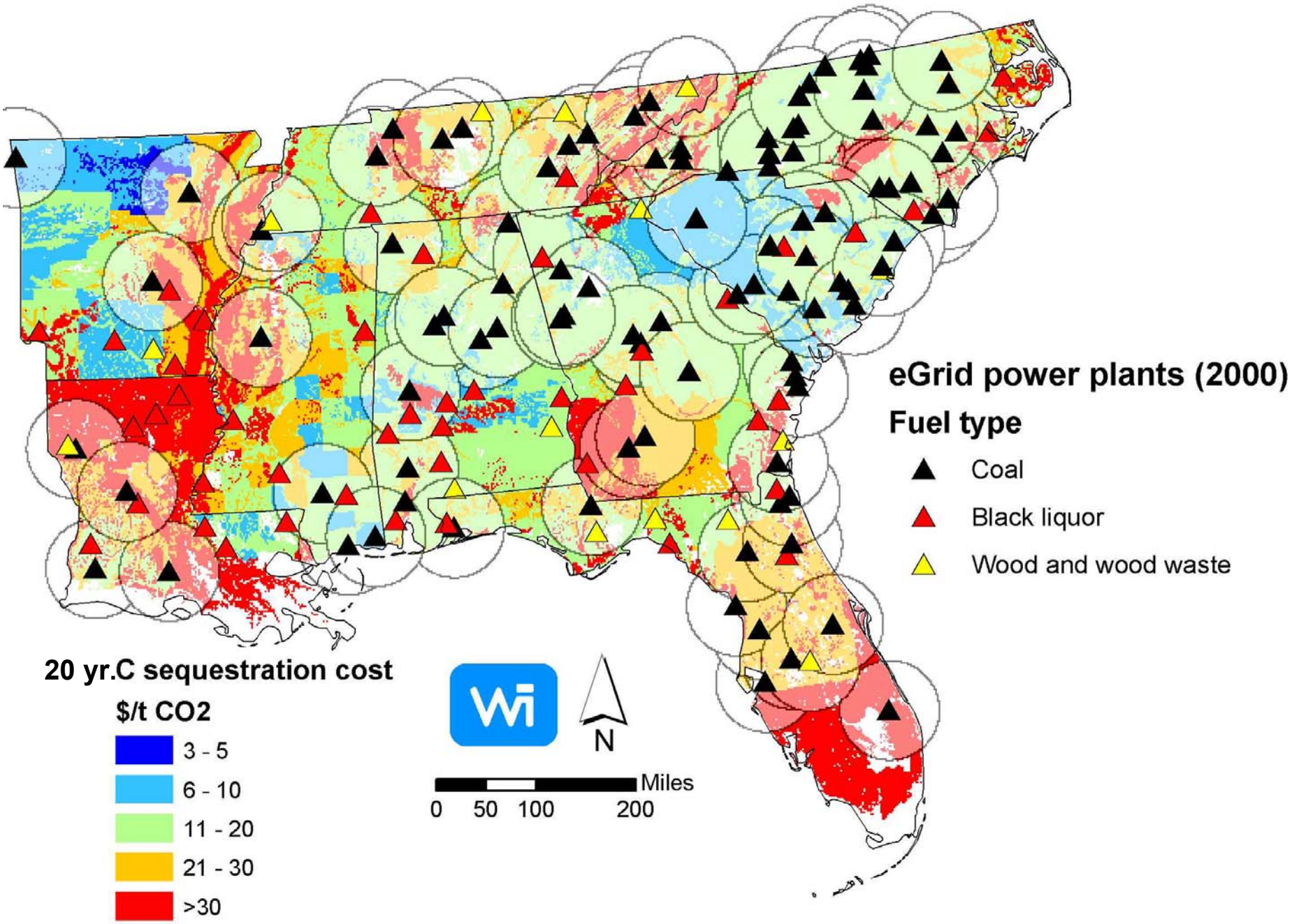
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Fuel type
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$/t CO2
3 - 5
6 - 10
11 - 20
21 - 30
>30
N
Miles
0 50 100 200

Conclusions

- Afforestation of crop and grazing lands is a financially attractive option for carbon sequestration.
- Combining afforestation activities with biomass fuel production enhances carbon benefits and ensures long-term fuel supply for biomass co-firing.
- Co-firing biomass fuels with coal can provide emissions benefits and help companies achieve renewable energy portfolio standards.

Acknowledgements

- US Department of Energy (DOE)
- Southern States Electricity Board (SSEB)
- Electric Power research Institute (EPRI)
- Mineral Acquisition Partners (MAP)
- WI colleagues Sandra Brown, Sean Grimland, John Kadyszewski, Nick Martin, Ian Monroe, Tim Pearson, Sarah Walker

How cost of biomass fuels affects price of power

Power generation

- Biomass-fired only, each $10 per ton fuel cost adds $0.01/kWh
- Co-fired with coal, each $10 per ton fuel cost adds $0.007/kWh